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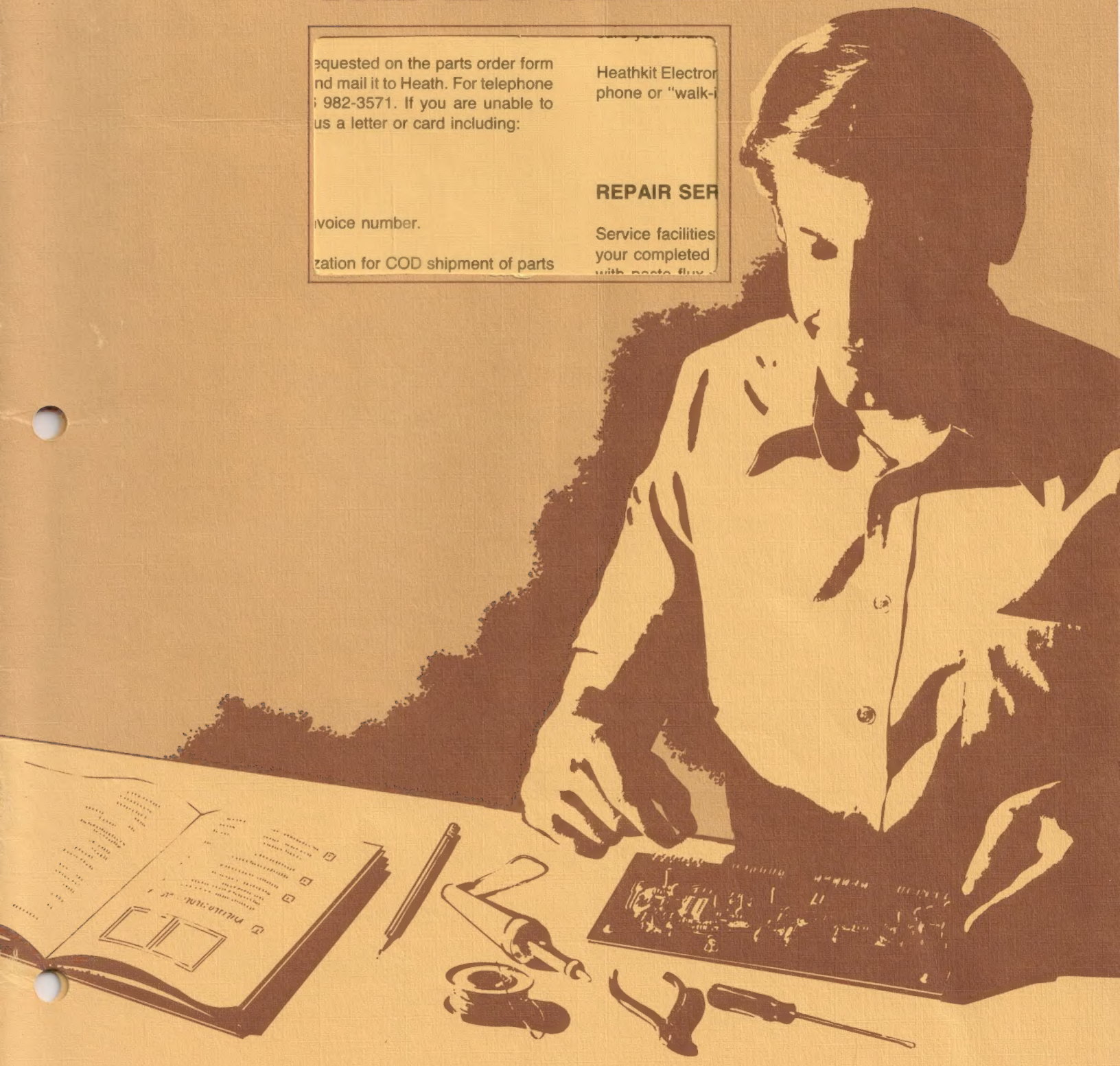

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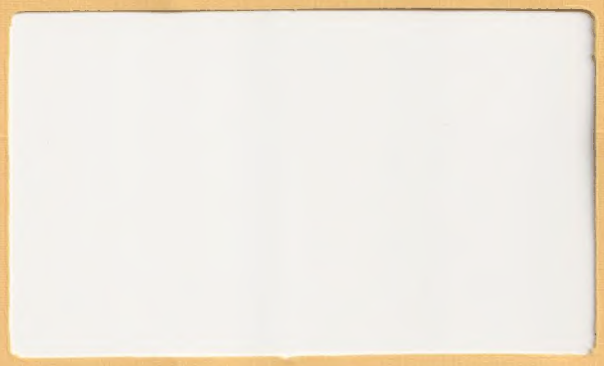


YOUR HEATHKIT 90-DAY LIMITED WARRANTY

Consumer Protection Plan for Heathkit Consumer Products

Welcome to the Heath family. We believe you will enjoy assembling your kit and will be pleased with its performance. Please read this Consumer Protection Plan carefully. It is a "LIMITED WARRANTY" as defined in the U.S. Consumer Product Warranty and Federal Trade Commission Improvement Act. This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Heath's Responsibility

PARTS — Replacements for factory defective parts will be supplied free for 90 days from date of purchase. Replacement parts are warranted for the remaining portion of the original warranty period. You can obtain warranty parts direct from Heath Company by writing or telephoning us at (616) 982-3571. And we will pay shipping charges to get those parts to you . . . anywhere in the world.

SERVICE LABOR — For a period of 90 days from the date of purchase, any malfunction caused by defective parts or error in design will be corrected at no charge to you. You must deliver the unit at your expense to the Heath factory, any Heathkit Electronic Center (units of Veritechnology Electronics Corporation), or any of our authorized overseas distributors.

TECHNICAL CONSULTATION — You will receive free consultation on any problem you might encounter in the assembly or use of your Heathkit product. Just drop us a line or give us a call. Sorry, we cannot accept collect calls.

NOT COVERED — The correction of assembly errors, adjustments, calibration, and damage due to misuse, abuse, or negligence are not covered by the warranty. Use of corrosive solder and/or the unauthorized modification of the product or of any furnished component will void this warranty in its entirety. This warranty does not include reimbursement for inconvenience, loss of use, customer assembly, set-up time, or unauthorized service.

This warranty covers only Heath products and is not extended to other equipment or components that a customer uses in conjunction with our products.

SUCH REPAIR AND REPLACEMENT SHALL BE THE SOLE REMEDY OF THE CUSTOMER AND THERE SHALL BE NO LIABILITY ON THE PART OF HEATH FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES, INCLUDING BUT NOT LIMITED TO ANY LOSS OF BUSINESS OR PROFITS, WHETHER OR NOT FORSEEABLE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

Owner's Responsibility

EFFECTIVE WARRANTY DATE — Warranty begins on the date of first consumer purchase. You must supply a copy of your proof of purchase when you request warranty service or parts.

ASSEMBLY — Before seeking warranty service, you should complete the assembly by carefully following the manual instructions. Heathkit service agencies cannot complete assembly and adjustments that are customer's responsibility.

ACCESSORY EQUIPMENT — Performance malfunctions involving other non-Heath accessory equipment, (antennas, audio components, computer peripherals and software, etc.) are not covered by this warranty and are the owner's responsibility.

SHIPPING UNITS — Follow the packing instructions published in the assembly manuals. Damage due to inadequate packing cannot be repaired under warranty.

If you are not satisfied with our service (warranty or otherwise) or our products, write directly to our Director of Customer Service, Heath Company, Benton Harbor MI 49022. He will make certain your problems receive immediate, personal attention.

Heathkit® Manual

for the

HERO JR ROBOT

Model RT-1

TECHNICAL 595-3271

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

TABLE OF CONTENTS

INTRODUCTION

This Technical Manual contains important information for both the technically-minded person, who wants to know how the HERO Jr Robot works, and for the technician who services it.

Although there are very few adjustments, and they will seldom require readjustment, complete instructions are presented to help you maintain peak operating condition of HERO Jr.

Should your Robot ever fail to operate properly, the "In Case of Difficulty" section will help you trace a problem to a particular area or circuit board. Then, if you are an experienced technician, you can track the problem to a given circuit or component and repair it. If you do not have training or experience in servicing digital electronic equipment, we strongly recommend that you limit your troubleshooting to locating a faulty circuit board. Then send that circuit board to the Heath Company for repair. (See "Service Information" inside the rear cover of this Manual.)

A "Theory of Operation" section features a "Block Diagram" and "Interconnect Drawing" where the various circuits and interconnecting lines are discussed in general, nontechnical terms. This is followed by a detailed "Circuit Description" of the individual circuits in a more technical language, which relates to the electronic components shown on the Schematic Diagrams.

The "Schematic Diagrams," "Circuit Board X-Ray Views," "Semiconductor Identification Charts," and "Replacement Parts Lists," will prove useful in troubleshooting, locating specific parts on the circuit boards, and ordering replacement parts. (See "Replacement Parts" on the inside rear cover.)

Finally, the "Appendix" section contains information on memory options and jumper placement allowing you to expand the use of the Robot.

In general, every effort has been made to make this Technical Manual complete and comprehensive for the service technician and the student of electronics and robotics.

SPECIFICATIONS

SENSES

Sound	Detects and quantifies ambient sound levels over the frequency range of 200 to 5000 Hz. Resolution is 1 part in 256. The sound sensor is essentially omnidirectional.
Light:	Detects and quantifies ambient light levels over the visible spectrum. Resolution is 1 part in 256. Sensor reception angle is about 30 degrees.
Sonar:	Ultrasonic – Polaroid type, 4"- to 25-foot range.
Motion:	Ultrasonic sonar detection (standard). Infrared sensor, six-array configuration (optional).
Speech:	Synthesized phonem-based system. Generates 64 phonemes which can be concatenated in any combination to simulate human speech or various sound effects. Reference pitch is hardware selectable, and instantaneously variable over four levels of inflection using software.

ELECTRONICS

Hardware:	6808 microprocessor, 32K monitor ROM, and 2K RAM. Provision for up to 24K RAM (or 8K RAM + 16K ROM) for future expansion. Two 6821 parallel interface adapters, CMOS clock, 4 MHz CPU crystal frequency, 1 MHz system clock frequency, 32.768 kHz real-time clock frequency. NOTE: The optional Cartridge Adapter provides up to 8K ROM.
Time:	Hardware 100-year calendar clock. Provides correction for daylight savings time. Counts seconds, minutes, hours, day of week, day of month, and month of year.
Keypad Functions:	0 through 9, A through F, and RESET. Each key is labeled with proper function (sing, play, poet, etc.).
Motors:	Steering — 180 degrees rotation, stepper type. Drive — 12 VDC, optical chopper feedback.

GENERAL

Operating Temperature	0° C to +40° C (32° F to 104° F) ambient.
Weight	21.4 lbs (9.7 kg).
Dimensions	19″ high × 18″ diameter (max).

ADJUSTMENTS

The adjustments you made during "Initial Tests" in the Assembly Manual were performed to assure nominal operation of your Robot. However, the following adjustment procedure will allow you to achieve optimum performance of the sound and light sensing, voice volume and pitch, and timekeeping of the clock.

You may want to perform only those adjustments for a function that appears to need it, or you may want to go through all of the adjustments to further familiarize yourself with the operation and capabilities of HERO Jr.

ROBOT DISASSEMBLY

Refer to Pictorial 1-1 (Illustration Booklet, Page 1) for the following steps.

1. Remove the front and rear body sections from the chassis assembly.

2. Remove and set aside the four 6-32 wing nuts that secure the head assembly to the chassis assembly. Then support the head assembly above the head plate to allow you access to the power/sense and CPU circuit boards.

SENSE

Depending on the sound and light levels that HERO Jr is exposed to, you may wish to change the setting of the controls that affect the sensitivity of these sensing devices. Pictorial 1-2 (Illustration Booklet, Page 2) shows the location of the controls used in the following adjustments.

A. Be sure the SLEEP-NORM switch is in the NORM position. Then press the RESET key. Within a few seconds, you should hear "ready" from the Robot's speaker.

SOUND

1. While you hold down the Robot's ENTER key, press and release the 0 key. The Robot will say: "Robot Wizard."

2. Enter F95D on the Robot's keyboard and press ENTER. Then adjust SOUND LEVEL control R337. As you adjust the control, make a constant monotone sound. The LEDs on top of the Robot will flash, counting in hexadecimal (which is a number system with a base of 16). As more LEDs light, the Robot's sound sensor will become more sensitive and respond to quieter and quieter sounds. Do not set the control so that all the LEDs are on; set it so only about half of them are on (or just ordinary room noises will make it respond).

3. Press the RESET key.

LIGHT

1. While you hold down the Robot's ENTER key, press and release the 0 key. The Robot will say: "Robot Wizard."

2. Enter F952 on the Robot's keyboard and press ENTER. Then adjust LIGHT LEVEL control R349. As you adjust the control, place a finger against the light sensor to block out most of the light. The LEDs on top of the Robot will flash (counting in hexadecimal). As more LEDs light, the Robot's light sensor will become more sensitive and respond to dimmer and dimmer light.

3. When you have the control set to a position that you want to try, press RESET.

SPEECH

You can adjust HERO Jr's pitch from baritone to soprano, and the volume from a whisper to a shout. Pictorial 1-2 (Illustration Booklet, Page 2) shows the location of the adjustment controls for the speech.

1. With the SLEEP-NORM switch in the NORM position, press the RESET key. Within a few seconds, you should hear "ready" from HERO Jr's speaker.

2. As HERO Jr proceeds through its phases, enter 7 (SPEAK) on the keyboard; then enter 0 twice. Adjust PITCH control R224 for the pitch you prefer and VOLUME control R234 for your desired listening level. NOTE: The proper setting of each of these controls is determined by your personal preference; however, others may have less difficulty understanding the Robot if the speech is a slow, rich baritone.

TIME

NOTE: Perform the steps in this section of your Manual only if your Robot does not keep time satisfactorily.

If you have a frequency counter, you can accurately set the time with a single adjustment. Otherwise, you can set the time with a known standard and compare every day, adjusting for fast or slow time as needed.

A. Make sure the POWER OFF-ON switch is in the OFF position.

B. Refer to Pictorial 1-3 (Illustration Booklet, Page 3) and disconnect socket S205 from the CPU circuit board. Then disconnect sockets S303, S305, and S306 from the power/sense circuit board. Set the head assembly aside temporarily.

C. Remove and set aside the four 4-40 × 1/4" screws that secure the power/sense circuit board to the four spacers below it. Then refer to Pictorial 1-4 (Illustration Booklet, Page 3) and position the power/sense circuit board as shown.

FREQUENCY COUNTER METHOD

1. Place the POWER OFF-ON switch in the ON position.

2. Make sure the SLEEP-NORM switch is in the NORM position.

3. Again refer to Pictorial 1-4 and connect your frequency counter to pin 2 of integrated circuit U213 on the CPU circuit board.

4. Adjust OSC TRIM capacitor C228 for a reading of 32.768 kHz ± .001 kHz on the counter.

5. Disconnect the counter from the CPU circuit board.

TIME STANDARD METHOD

1. Place the POWER OFF-ON switch in the ON position.

2. Make sure the SLEEP-NORM switch is in the NORM position.

3. Preset OSC TRIM capacitor C228 with its slot horizontally as shown in Pictorial 1-4 (Illustration Booklet, Page 3). NOTE: Be sure the metal drop on the capacitor is positioned as shown.

4. Enter RESET on the keyboard. After a short pause, HERO Jr should say "ready."

5. Enter 7 (SPEAK) on the keyboard. HERO Jr should say: "Enter two digits for a selection."

6. Enter 01 on the keyboard. HERO Jr should respond with the current day of the week, month, date, year, and time in hours and minutes (AM or PM). Example: "It's Wednesday February 29, 1984 – 8:45 PM."

7. After at least 24 hours, repeat steps 1, 2, 4, 5, and 6. HERO Jr will then give you its current time. If the clock has gained time, adjust OSC TRIM capacitor C228 slightly counterclockwise. If the clock is slow, adjust the capacitor slightly clockwise.

8. Check the clock against a known time standard every 24 or more hours. Readjust C228 as necessary until the clock keeps reasonably accurate time.

DIRECTION

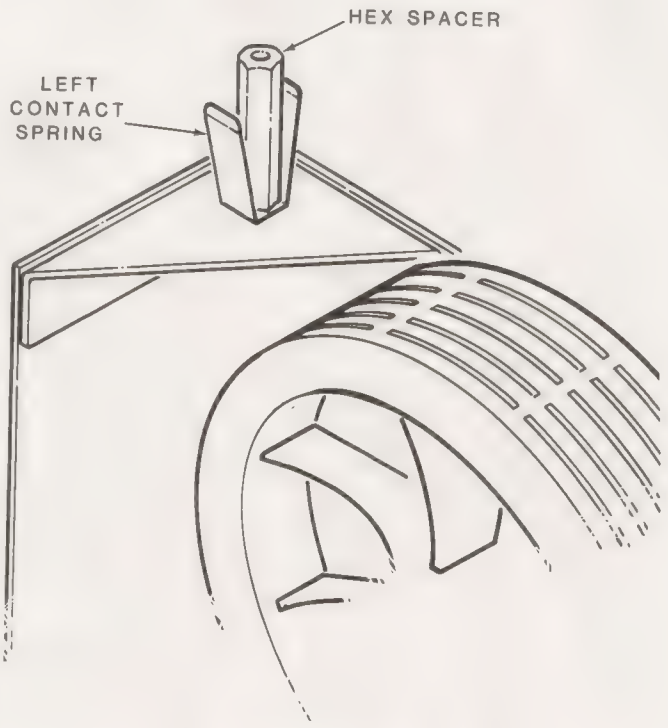
If you notice that your Robot is not traveling in a straight line as he moves on a level surface, refer to Pictorial 1-5 and use the following procedure to improve this condition:

A. If the Robot is veering to the right, carefully bend the left contact spring a small amount away from the hex spacer. Then check and see if the Robot is following a reasonably straight line.

B. If the Robot is veering to the left, carefully bend the left contact spring a small amount towards the hex spacer. Then check and see if the Robot is following a reasonably straight line.

C. Continue to bend the left spring, as necessary, until you obtain a satisfactory result.

NOTE: Because several possible forces may act upon the Robot, and in turn determine how straight the travelled path is, this adjustment will probably only correct some of the error you detected.



PICTORIAL 1-5

ROBOT REASSEMBLY

Refer to Pictorial 1-1 (Illustration Booklet, Page 1) for the following steps.

NOTE: Complete step 1 only if you performed the "Time" adjustment in this section of the Manual. Otherwise, proceed to step 2.

1. Reinstall the power/sense circuit board on the four spacers using the four 4-40 × 1/4" screws you removed earlier.

2. Position the head assembly above the chassis assembly; then refer to Pictorial 1-2 (Illustration Booklet, Page 2) as you reconnect the four plugs that you previously disconnected from the circuit boards.

3. Be sure the head assembly is positioned properly on the chassis assembly. Make sure there are no wires pinched between the head mounting brackets and the head plate.

4. Use the four 6-32 wing nuts you set aside earlier to secure the head in place.

This completes the "Adjustments."

IN CASE OF DIFFICULTY

Begin your search for any trouble that occurs after assembly by carefully following the steps listed below under "Visual Checks." After you complete the "Visual Checks," refer to the "Troubleshooting Charts." Start with the chart labeled "General Problems" and locate your problem in the left column of this chart. The right column of the chart shows you which components could be at fault and may give you typical voltage indications on a specific component. Refer to the "Circuit Board X-Ray Views" for the physical locations of parts on the circuit boards.

VISUAL CHECKS

1. Recheck the wiring. Trace each lead with a colored pencil on the Pictorial as you check it. It is frequently helpful to have a friend check your work. Someone who is not familiar with the unit may notice something that you have consistently overlooked.

2. About 90% of the kits that are returned to the Heath Company for repair do not function properly due to poor connections and soldering. Therefore, you can eliminate many troubles by reheating all of your connections to make sure they are soldered as described on Page 14 of the Assembly Manual. Be sure there are no solder "bridges" between circuit board foils.

3. Check to be sure all transistors and diodes are in their proper locations. Make sure each lead is connected to the proper point. Make sure that each diode band is positioned above the band printed on the circuit board or as directed in its step.

4. Check electrolytic capacitors to be sure their plus (+) or minus (−) mark is at the correct location.

5. Check to be sure that each IC is properly installed, and that the pins are not bent out or under the IC. Also, be sure the ICs are installed in their correct locations.

6. Check the values of the parts. Be sure in each step that you wired the correct part into the circuit, as shown in the Pictorial. It would be easy, for example, to install a 22 kΩ (red-red-org) resistor where a 2200 Ω (red-red-red) resistor should have been installed.

7. Check for bits of solder, wire ends, or other foreign matter which may be lodged in the wiring.

8. Be sure all the component leads are cut close to the foil on each circuit board, so the leads do not short to the chassis after the circuit boards are installed.

9. A review of the "Circuit Description" may also help you determine where the trouble is.

If you still have not located the trouble after you complete the "Visual Checks," and a voltmeter is available, check voltage readings against those shown on the Schematic. Read "Precautions for Troubleshooting" before you make any measurements. NOTE: All voltage readings were taken with a high-input impedance voltmeter. DC voltages and resistances may vary as much as ± 20%.

PRECAUTIONS FOR TROUBLESHOOTING

Be sure you do not short any terminals to ground when you make voltage measurements. If the probe should slip, for example, and short across components or voltage sources, it is very likely to cause damage to one or more components.

NOTE: In the unusual event that you are unable to resolve a difficulty, refer to the "Customer Service" information inside the rear cover of this Manual. Your Warranty is located inside the front cover.

TROUBLESHOOTING CHARTS

The following charts list the condition and the possible causes of several malfunctions. If a particular part is mentioned as a possible cause, check that part to see if it was correctly installed. Also check the parts that are connected to it for poor connections. It is also possible, on rare occasions, for a part to be faulty and require replacement.

CONDITION	POSSIBLE CAUSE
Robot completely inoperative, green LED is off (after placing OFF-ON switch to ON and pressing the RESET switch).	1. Wiring of batteries. 2. Low battery voltage. 3. Fuse F1 blown. 4. Keyboard. 5. U302, Q301, Q302. 6. U221, U222. 7. U201. 8. Jumper at TP201 disconnected.
Robot does not speak; however, red data LEDs flash on and off.	1. R234 turned fully CCW. 2. Q204, Q205. 3. U201, U215, U223, or U224. 4. SP2.
Robot's speech is distorted, while red data LEDs flash on and off.	1. R224 misadjusted. 2. D202, Q202, Q203. 3. U201, U215, U223.
Red data LEDs do not flash, while Robot's speech is okay.	1. U225. 2. P205. 3. Keyboard LEDs installed backwards.
Malfunction in memory circuits.	1. U209 (if no 5.0 volts). 2. U203 not installed. 3. Jumpers J201 through J210 incorrectly installed. 4. U201. 5. U202.

Troubleshooting Charts (Cont'd.)

CONDITION	POSSIBLE CAUSE
Robot says: "Sonar malfunction." Also, no sound from sonar transducer.	1. A4 not connected to P305. 2. U214 or U215. 3. U201. 4. U304 or U314. 5. U307, U308, or U313.
Steering motor does not operate.	1. P203. 2. A1. 3. P309. 4. U201 or U214. 5. Q316, Q317, Q318, or Q319. 6. U213, U221.
Steering motor reaches limit switch, but then continues to run.	1. Plug on P203 pins 9 and 10 not connected or reversed.
Malfunction in light sensor; however, red data LEDs flash on and off.	1. LDR1 or P306. 2. U201 or U214. 3. U304 or UQ314. 4. U215 or Q309. 5. Q311, Q312, or U306.
Drive wheel is not turning.	1. A2 wiring. 2. A2. 3. P308 or P311. 4. U201, U214, or U215. 5. A3. 6. U304 or U305. 7. Q321.
Data LEDs do not flash on and off.	1. P301. 2. U304. 3. D308.

Troubleshooting Charts (Cont'd.)

CONDITION	POSSIBLE CAUSE
Unable to enter time or date.	1. Keyboard. 2. P204 or P205. 3. Q206, Q207, Q208, or Q209. 4. U214. 5. U201. 6. U213, U221. 7. U211 or U212.
None of the keyboard keys can be activated. However, RESET key functions properly.	1. Keyboard. 2. U213, U221. 3. U201 or U202. 4. U214 or U215. 5. U203, U204, U205, U206, U207, or U208. 6. Jumpers J201 through J210 incorrectly installed.
Robot says: "Low battery." However, the batteries check out okay.	1. D304. 2. D305. 3. U303. 4. U214 or U201.
Batteries will not take charge.	1. Battery charger. 2. P1 or J1. 3. P307. 4. U301.
Drive wheel is turning forward and backward in the "explore" mode.	1. Distance between A3 and disk is not approximately 1/8". 2. Connector to A3 removed. 3. P311. 4. U304 or U305. 5. U201 or U214.
Drive wheel turns only in reverse.	1. RY301. 2. Q322. 3. U214, U201.

THEORY OF OPERATION

Refer to the Block Diagram (Illustration Booklet, Page 4) while you read the following information.

CPU (central processing unit) U201 forms the heart of the HERO Jr Robot, while integrated circuits U203 through U208 make up the brain.

Whenever OFF-ON switch SW1 is ON, even with the Robot in the sleep mode, 5-volt regulator U209 (providing the V_{CA} voltage) is activated. This results in power being applied to the real-time clock, reset circuits, and address decoder. The memory may or may not be connected to this supply, depending on the setting of the supply jumpers (J202, J204, and J206) on the CPU circuit board.

Most of the other circuits derive their power from 5-volt switching regulator U302 (providing the V_{CC} voltage), which is turned off in the sleep mode. A few circuits are connected to the 12-volt supply; most of these circuits, however, are inactive in the sleep mode.

In the sleep mode, real-time clock U213 pulses the switching regulator once every 5 seconds to turn it on, and the CPU checks the inputs. If no wake-up signal is received by the CPU, it will go back to sleep; also, the regulator will drop out. After the CPU comes out of the sleep mode, it goes to the high end of memory (ROM), which tells it to check the inputs from the keyboard, remote, and other possible sources.

Interface ICs, called Peripheral Interface Adapters (PIAs), are used to connect the CPU to the various input and output devices, like the sound sensor and the speech, respectively. There are two reasons for using PIAs. The CPU does not have enough power available to drive the output circuits directly, and the PIAs provide a means of addressing the outputs.

A typical output device works as follows: The CPU puts out an address for the device, and the PIA is selected through the address decoder. Then the CPU puts the information on the data lines. The informa-

tion gets routed through the PIA to a driver, which turns on the output. For example, when the command is to drive, the CPU puts out an address to activate PIA U214. Then the data is put on the proper data line (D1 – U201, pin 32). The signal from pin 11 of U214 then turns on motor driver Q321, which turns on motor A2. The same procedure is repeated on the other outputs.

A typical input device works as follows: A signal is generated at a sensor, keyboard, or remote receiver. This signal is conditioned to proper levels for the PIA. The CPU reads the PIA and acts upon the command. For example, in the case of the wheel encoder, an LED (light-emitting diode) in light sensor A3 illuminates the encoder disk. As the drive wheel is turning with the disk, the reflected light flashes on and off. The reflected light pulses are picked up by A3, conditioned by U305, and routed to U214, pin 18. The CPU can now "read" the pulses to determine if the wheel is turning.

The speech interacts with the CPU; the CPU turns on the power to the speech circuitry and sends the data. Next, another line from speech IC U223 is activated to tell the CPU that more data is needed. The light and sound sensors go through the A/D converter (U306). The CPU turns on the supply, and provides timing signals and a start signal. The sonar sensor requires a turn-on and an initiate signal in order for it to work.

When you use the keyboard, it directs the CPU to either read the time of the real-time clock, or read some part of memory; the instruction stored in that memory location is then performed.

CIRCUIT DESCRIPTION

Refer to the Schematics (fold-in) and Block Diagram (Illustration Booklet, Page 4) while you read the following information. The component numbers are arranged in the following groups to help you locate specific parts on the Schematic, circuit boards, and chassis.

1 – 99	Parts mounted on the chassis.
100 – 199	Parts mounted on the keyboard circuit board.
200 – 299	Parts mounted on the CPU circuit board.
300 – 399	Parts mounted on the power/sense circuit board.

BATTERY CHARGER

The output voltage of the battery charger is about +12 volts at maximum charge current (780 mA). As the batteries charge, the charging current drops until the output voltage increases to a maximum of about +16 volts. At this voltage, the batteries are fully charged and the current, which produces a trickle charge, reaches its minimum value.

CHARGING REGULATOR

The charging regulator circuit, which consists of U301 and associated components, provides a variable charging current to the batteries. The charger operates in a current-limiting mode to deliver a safe, maximum current when the batteries need charging. Just before the batteries are fully charged, the charger automatically switches to a floating-charge mode, providing a constant voltage. This floating charge can be maintained almost indefinitely without damaging the batteries.

The output voltage of regulator U301 is determined by resistors R302 and R303. When this voltage is reached, only a float charge is maintained, because of the current passing through R301. From the OUT lead (3) of U301, the output voltage is fed through jumper wire W302 to plug P307-1 (pin 1). The voltage is next fed through plug P1-1 & 4 to Off-On switch SW1 lug 2, and through fuse F1 to the batteries.

When the charger's output voltage reaches its lowest value, which happens when maximum current is being drawn from it, U301 acts as a series resistor. That is, the voltage drop across U301 varies with the current passing through it. Thus, the maximum charging current to the batteries is limited by the internal impedance of both the charger and U301.

LOW-VOLTAGE SENSE CIRCUIT

The low-voltage sense circuit, which is made up of comparator U303 and its associated components, compares the battery voltage to the voltage across zener diode D304. This 5-volt reference voltage is applied to the noninverting input (pin 2) of U303. The battery voltage is applied to divider R316 and R317, and the voltage across R317 is fed to the inverting input (pin 3) of U303.

When the batteries are charged, the voltage at U303-3 will be greater than the voltage at U303-2. Therefore, its output (pin 7) will be low. However, if the battery voltage drops below 10 volts, the voltage appearing at U303-3 will fall below 5.0 volts. When this happens, U303-7 goes high, and signals a low-battery condition.

D305, C315, and C316 ensure that U303 does not generate a false low-battery indication. When power is applied, C315 charges through R317. This causes the voltage across R317 to drop from +13 volts to about +7.0 volts. This voltage keeps U303-7 low. If C315 were missing, U303-7 would indicate a low-battery condition almost immediately. This is because the reference voltage at U303-2 reaches 5.0 volts very quickly, while it would take several seconds for C316 to charge through R316.

If the Robot turns on one of its motors during normal operation, the motor will generate a negative spike on the motor supply line. D305 will be reverse-biased to prevent C315 from discharging through R316/R317, while C316 filters the negative spike being fed through R316. This combined action prevents U303 from producing a low-battery indication when a motor is turned on.

5-VOLT SWITCHING REGULATOR

The switching regulator supplies +5 volts to the Robot's logic circuits. This regulator is made up of U302, Q302, Q301, and associated components. The circuit operates by rapidly switching series pass-transistor Q301 on and off. The ratio of the on time to the off time determines the average voltage applied to the V_{cc} line.

U302 is a control circuit that produces a pulse-width modulated voltage. It uses an internal oscillator to operate on a fixed (≈25 kHz) frequency, which is determined by R309 and C308. This oscillator signal is coupled through an internal gate to drive Q302 and Q301. Inside U302, an error amplifier and a comparator circuit determine how long the oscillator signal will be present at pins 12 and 13.

Pins 1 and 2 of U302 are the inputs to the error amplifier. The inverting input (pin 1) monitors V_{cc} (+5 volts) through R304. The voltage at pin 2 is a reference voltage, which comes from the output (pin 16) of an internal 5-volt regulator.

The duty cycle of the pulse at U302-12 & 13 depends on the voltage difference between U302-1 & 2. If the output voltage should increase, the voltage at pin 1 will become more positive than pin 2. This causes the pulse width at pins 12 and 13 to decrease. As a result, the on-time of Q302 and Q301 decreases to reduce the filtered voltage at the positive side of C311.

If, on the other hand, the output voltage should decrease, U302 will increase the duty cycle of the pulse to keep Q302 and Q301 conducting longer, thereby increasing the voltage.

To allow U302 to operate, the CPU normally keeps the shutdown line (U302-10) at logic 0. If you place Normal-Sleep switch SW2 (on the switch panel) in the Sleep position, the CPU will place a logic 1 on this line. This logic 1 turns off Q301 to remove the 5-volt logic supply during the sleep mode.

C307 and R308 filter the error amplifier output at U302-9. This provides compensation to prevent the output from hunting around the 5-volt level.

NEGATIVE 10-VOLT SUPPLY

The output signal at the collector (C) of Q301 is a square wave, which is derived from the on/off-pulses of Q301. These pulses are filtered and used to generate both the positive 5-volt (V_{cc}) and the negative 10-volt supplies.

C312, D302, D303, and C313 form a half-wave voltage doubler for the negative 10-volt supply. During the positive half cycle of the square wave, C312 charges to −5 volts (through D302). During the negative half cycle of the square wave, C313 charges to −10 volts (through D303) by adding the −5 volts from the square wave to the −5 volt charge on C312. This −10 volt supply is used for the RS-232 interface.

SENSE CIRCUITS

The sense circuits produce analog signals as they detect and amplify ambient sound and light. These signals are then converted to an 8-bit code which can be read by a computer through an I/O port.

Sense Enable

To enable the sense circuits, the CPU brings data bit D4 to logic 1 at port $D841 (U215-11) on the CPU circuit board. The logic 1 is coupled through P201-20 to U304-2. U304A turns on Q314, which couples +5 volts to the sonar and sense (sound and light) circuits.

To save battery power, the CPU can turn off the sense circuits when they are not in use.

Sound Sense Amplifier

The sound sense amplifier consists of dynamic microphone SP1, transistors Q303 through Q308, and associated components.

SP1, which is a 45-ohm speaker used as a microphone, is mounted on the chassis assembly. Its output is coupled through C319 and R323 to the base (B) of amplifier Q303. Q304 provides further amplification before sending the signal to final amplifier Q306 and Q307. R337 sets the total gain for this stage. Q308 provides impedance matching for the input (pin 2) of A/D (analog-to- digital) converter U306.

Light Sense Amplifier

The light sense amplifier consists of light-dependent resistor LDR1 on the head assembly and transistor Q312 on the power/sense circuit board.

The resistance of LDR1 varies inversely with the ambient light level. If the surrounding light should get brighter, the current through R345 and R351 would increase. Q312 would conduct more current, and the voltage across R353 would increase. The signal at the emitter (E) of Q308 is coupled to the input (pin 2) of A/D converter U306.

Sound/Light Switch

The sound/light switch selects whether the sound circuits or the light circuits are to be connected to the A/D converter. Only one of these two circuits can be active at one time.

To turn on the sound circuits, for example, the CPU places a logic 0 on line D2 of port $D841 (U215-2). This turns off Q305 to allow the sound signal to pass to the base of Q306. At the same time, Q309 con-

ducts to turn on Q311. Q311 shorts the light signal path to Q312 and turns off Q312, thereby isolating the light circuits.

To turn on the light circuits, D2 of port $D841 goes high. Q311 turns off to allow the light signal to pass to Q312. Q305 turns on to short the sound signal and to turn off Q306, Q307, and Q308.

A/D CONVERTER

A/D converter U306 transforms the analog signal at pin 2 into an 8-bit digital signal at pin 6.

U306 is a successive approximation, serial, 8-bit A/D converter. R354 and R355 set a reference voltage to U306-5. The CPU puts clock pulses on D4 of port $D841 (U215-14). These pulses are used by U306-7 as clock pulses. $\overline{CS}$ for U306-1 comes from D3 (pin 30) of CPU U201 through port $D841 (U215-13). The serial output of the A/D converter is read by D3 (pin 28) of CPU U201 through port $D841 (U215-15), with the most significant bit being read first. The converter has an 8-bit resolution.

POLAROID RANGING SONAR

This circuit detects the presence of an object within a distance of about 4 inches to 25 feet from the Robot.

During operation, the sonar transducer is transmitting a pulse toward the target. The resulting echo is then detected by the transducer. Because we know that the speed of sound is 1086 feet per second at sea level, we can calculate the distance between the transducer and the object, based on the time it takes from the initial transmission to echo detection. For example, if it takes about 3.65 msec (milliseconds) for a transmitted pulse to leave the transducer, strike a target, and return to the transducer, the Robot is two feet away from the target.

Figure 1 shows the waveforms involved in making the sonar work.

IC U307, which is a sonar ranging control, has a built-in oscillator whose frequency is controlled by ceramic resonator Y301. They cycle of U307 begins

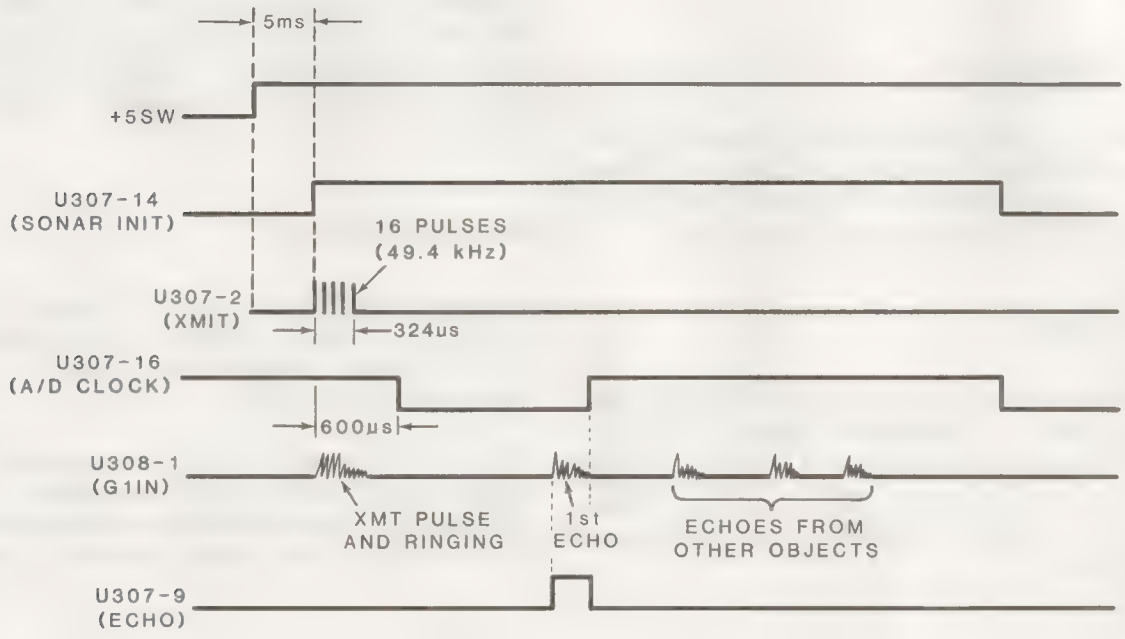


Figure 1

when the Sense Enable line (P301 – 20) is taken to a logic 1. This powers up all the devices associated with the sonar circuits as the collector of Q314 is taken high. It takes 5 ms for all the internal latches in U307 to reset and for the ceramic-resonator-controlled oscillator to stabilize. The INIT line, going from U214-19 on the CPU circuit board to U307-14 on the power/sense circuit board, is then pulled high. This results in U307 transmitting a burst of 16 pulses.

For the first 16 transmit cycles, the oscillator frequency is obtained by dividing the resonator frequency by 8.5. For the remainder of the transmit cycle, the resonator frequency is divided by 4.5.

The internal blanking of U307 disables its receive input (pin 8) after the INIT line is taken high; this is done to blank out the transmit pulses and exclude false receive input signals that may be produced by transducer ringing. The CPU controls the blanking with the same line that is used for the clock of the A/D converter. U307 also provides a synchronous 4-bit gain control output signal, which is used to control the gain of sonar ranging receiver IC U308.

The transmit pulses at U307-2 are coupled to the base of Q313, which drives step-up transformer T301. The output pulses from T301 are coupled through C333 to Polaroid ranging transducer A4. D306 and D307 limit the voltage being applied across T301 to 300 volts peak-to-peak.

Transducer A4 transmits pulses, and also receives the return pulses. The signal (receive pulses) is first coupled through T301 and R361 to U308-1. The signal is then coupled from the output (pin 6) of the 1st gain stage to the input (pin 7) of the 2nd gain stage. From the output (pin 9) of this stage, the signal is coupled to U307-8.

R358 sets the bias of U308. The amplifier gain is set by R359 and the detect level by R361. L302 and C337 provide proper tuning and determine the Q-factor of the circuit at the received frequency. The gain of the amplifiers is adjusted as the distance of the returned echo changes. This is to compensate for weak signals reflected from objects that are further away.

C335 integrates the signal present at U308-9 so that one or two noise pulses will not be recognized. The signal is then coupled to U307-8 and latched to U307-9. U304 buffers and inverts the signal which is then coupled to U215-18 on the CPU circuit board, where it is read by the CPU. The CPU calculates the distance based on the time elapsed between the moment the INIT line was taken high and the echo is picked up by the transducer. U308-2 provides clamping for the secondary of T301 when it is used for transmit. C334 provides filtering for the logic supply.

WHEEL DETECTOR

A light-emitting diode (LED) inside light sensor A3 generates an infrared signal, which is beamed at the encoder disk. The signal reflected from the disk is then picked up by another section of the light sensor. When the encoder disk rotates, the reflected signal beam is interrupted. This signal is shaped into a square wave by U304 and U305 and associated circuitry. This square wave is routed through P301 to U214-18. At this time, the CPU can read the signal and determine if the Robot is moving.

ACCESSORY CIRCUITS

D308 and C341 are used to supply power to the optional Infrared Motion Detector, Model RTA-1-1. When the Infrared Motion Detector senses a human being, it sends a signal from P303-8 to U304-12. This signal is shaped and inverted and then routed to U214-17 ($D821 bit D7). At this moment, the CPU can read the state of D7.

Q315 is used with the Heath Model GDA-2800-3 Wired-Circuit Transmitter. The CPU sends a signal to U215-19 on the power/sense circuit board. This signal is routed to the base of Q315, which turns on, resulting in the transmitter being activated.

5-VOLT REGULATOR

U209 is a 5-volt regulator that supplies power to the devices that are kept on in the sleep mode. Real-time clock U213, reset circuits U221 and U222, and address decoder U202 are always on in the sleep mode. If you wish any of the memory devices (RAMs) to retain memory, you can connect them to the 5-volt supply by installing jumper sockets in the proper places on the CPU circuit board plugs.

KEYBOARD

The hex keyboard (0-F) is connected to port $D820, bits D0-D7 (U214-2 through 9). The keys are connected in a 4 x 4 matrix. Whenever a key is activated, the CPU determines which two lines are connected together, and thus recognizes which key was pressed. The reset key is connected to the reset circuit. The keyboard is used to control the functions of HERO Jr. This includes placing the Robot into different personality modes, and to enter date and time and special dates.

REMOTE INTERFACE

The remote control receiver option (Model RTA-1-2) connects to Q206 through Q209. In turn, the collectors of Q206 through Q209 are connected in parallel with the keyboard columns port $D820, bits D0-D3 (U214-2 through 5). Whenever one of the lines from the receiver becomes active, the data line at the port will be pulled low and the CPU will be able to act on the command.

RS-232 INTERFACE

The optional RS-232 interface (Model RTA-1-3) is used to connect a computer terminal to your Robot. U216 is a parallel-to-serial adapter. This adapter is assigned port $D880 bits D0-D7 (U216-22 through 15). The serial output from U216-6 is routed via output driver U219 and plug P203-6 (RS232 XMIT) to RS-232 connector J2.

The input signal, which is fed to the RS-232 connector (J2) from an external source, is routed to the base of Q201. From the collector of Q201, the signal is fed to the input (pin 2) of adapter U216. If no signal is present on the base of Q201, its bias voltage turns it on; thus, its low collector voltage "tells" U216 that no external source (a terminal, for example) is hooked up to the RS-232 connector.

You may select the desired baud rate (9600, 4800, 2400, 1200, 600, 300, or 150) by plugging a 2-pin jumper socket onto the corresponding two pins of switch SW201. The different baud rates are generated by using U217, U212C, and U218 to properly divide the 1 MHz signal produced by the CPU clock.

CPU PIN-OUT DESCRIPTION

Microprocessor U201, which is a 6808 operating on 1 MHz, is the Robot's CPU (Central Processing Unit). The 4 MHz frequency of crystal Y201 is divided by four inside U201 before it is being applied to the circuitry. The 1 MHz clock output is present on pin 37, the E (enable) line.

Pin 5 is the VMA (valid memory address) line. A short time after placing an address on the address bus, the CPU asserts this line to tell memory or I/O that the address is valid.

The address lines consist of pins 9 through 25. This is a 16-bit address bus, which permits the CPU to address up to 64 kilobytes of memory or I/O ports. Note that the CPU treats I/O ports as memory locations, thus limiting the amount of memory the system can have.

Pins 26 through 33 make up the data bus. These lines can be input or output lines, depending on whether the CPU is reading or writing data. Under certain conditions, such as during reset, these lines are in a high-impedance state.

Pin 34 is the R/W (read/write) line. This line goes high when reading memory or a port; it goes low when writing to memory or a port.

The $\overline{IRQ}$ (interrupt request) line enters the CPU at pin 4. If one of the peripheral ports requests an interrupt, the port asserts this line. If the CPU does not have interrupts masked, it will finish the current instruction and then process the interrupt. Once this is done, it is up to the CPU to raise pin 4 back to logic 1. It does this by addressing the appropriate port and latching a logic 1 onto the line that feeds back to pin 4. This interrupt is pulled high by R202.

The nonmaskable interrupt at pin 6 operates just like $\overline{IRQ}$ at pin 4 with one major difference; it can not be disabled through software control.

MR (memory ready) at pin 3 is brought low to compensate for slow RAMs. $\overline{HALT}$ at pin 2 can be brought low to stop the CPU. Neither of these lines are used in the Robot, so they are tied high.

NOTE: The 6808 CPU is software compatible with the 6800 microprocessor. Therefore, if you know how to program one, you will have no problems programming the other.

U227 and U228 are address buffers, which supply drive power to the address lines so they can handle all the devices connected to them.

U226 is a bidirectional address buffer, which provides the data lines with enough power to drive all the devices connected to them.

ADDRESS DECODER

As mentioned previously, the 6808 CPU does not distinguish between memory and I/O. In the RT-1, RAM is located at the bottom of the 64K address range, I/O ports are located at the $D800 point, and system ROM is located in the top 32K. The address decoder ensures that the right area is accessed. Here is how it works:

Address lines A11-A15, VMA, SLP (sleep), RST (RESET), R/W, and EE (clock) are connected to address decoder U202. The output lines (pins 12-19) go low when addressed to select memory or I/O devices.

The following table shows which particular address is selected.

ADDRESS	IC ENABLED	U201 OUTPUT PIN	FUNCTION
$0000 – 1FFF	U203	12	MEMORY
$2000 – 3FFF	U204	13	MEMORY
$4000 – 5FFF	U205	17	MEMORY
$6000 – 7FFF	U206	18	ROM
$8000 – BFFF	U207	15	MONITOR ROM
$D810 – D81F	U213	19	REAL-TIME CLOCK
$D820 – D83F	U214	19	I/O INTERFACE
$D840 – D85F	U215	19	I/O INTERFACE
$D880 – DFFF	U216	19	RS-232 INTERFACE
$C000 – D7FF $E000 – FFFF	U208	16	MONITOR ROM
OUTPUT ENABLE	U203-U205 U207,U208	14	

MEMORY

The U204 and U205 slots can be used for RAM or ROM devices. Each slot can accomodate 2K × 8 or 8K × 8 of memory. U207 and U208 are 16K × 8 monitor ROMs, which initialize the various circuits. U203 can be a 2K × 8 or 8K × 8 RAM whose lower part is reserved for the operation of the monitor. U206 can be either a 4K × 8 or 8K × 8 ROM.

JUMPER SOCKETS

U203 through U205, when used as RAM, can either be hooked up to retain or to turn off memory in the sleep mode. If the information does not have to be saved, you should turn off power to the device during sleep, to conserve battery power.

SPEECH

These circuits can generate the 64 basic sounds that make up the English language . Under microprocessor control, these 64 sounds (called phonemes) may be strung together in any sequence to simulate human speech. To provide inflection, the CPU can vary the instantaneous pitch of any phoneme over four levels. Reference pitch and volume may be adjusted by using controls on the CPU circuit board.

To speak a phoneme, the CPU sends a six-bit code from port $D840 to speech synthesizer U223-9 through 14. The CPU then places a logic 1 on CA2 of U215 (pin 39, port $D842) and on the strobe line (pin 7) of U223. U223 responds by latching the six-bit code into the synthesizer to begin generation of the phoneme. The generated phoneme appears at U223-21 & 22 where it is coupled through R233 and placed across R234. A portion of the phoneme is then coupled to the amplifier circuits.

When the phoneme is completed, the request line from U223, pin 8 goes high. This connects to bit CA1 of U215-40 (port $D842) to tell the CPU that U223 is ready to process another phoneme. The CPU responds by sending new phonemes, which start the process all over again. This sequence continues until all phonemes in the word or sentence have been output.

U223-2 & 3 control the instantaneous pitch of the phoneme being voiced. Manipulation of these two lines during phoneme generation produces inflection. The CPU controls these pitch lines by placing the proper code on D6 and D7 of port $D840 (U215-8 & 9).

R223, R224, and C231 are the frequency-determining components of the oscillator in U223. R224 can be adjusted to determine the reference pitch and the speed at which the phoneme is pronounced.

The phoneme signal couples through R233, R234, and C235 to U224, pin 8. U224 provides enough gain to directly drive an 8-ohm speaker through C241.

When the speech circuitry is not in use, the Robot can conserve battery power by turning off Q205. To do this, the CPU places D1 of port $D841 (U215-10) at logic 0. This couples to the base of Q204 to turn off Q204 and Q205.

R226 maintains power to U223 when Q204 and Q205 are shut down. This is necessary to prevent U223 from getting damaged by the voltages on its input pins. Since U223 is a CMOS device, it draws very little current from the batteries. D203 blocks the voltage at R226 from the audio amplifier.

D202 and R225 are used as a level shifter to convert the higher logic voltage of U223 to the TTL level required for U215.

Q202 and Q203 are the speech inflection drivers, which provide a higher drive voltage than what is supplied by U215. These transistors use the +12-volt supply to provide sufficient voltage for speech inflection.

REAL-TIME CLOCK

The real-time clock circuit is contained within U213. U221E and crystal Y202 form the 32.768 kHz reference signal. This signal is coupled through buffer amplifier U221A to U213-2. Counters within U213 count seconds, minutes, hours of the day, days of the week, date, month, and year.. These counters may be loaded to set the time and date, or to read the time and date over the data lines (pins 4 through 11).

U213 uses a multiplexed bus structure. To accomplish the interface, the bus cycle must be divided into two parts. During the first part of the cycle, the address is put on the data lines and, during the second part of the cycle, data is input or output. U213-14 (AS) is used to indicate when address is valid, and U213-17 (DS) is used to indicate when data is valid.

U211A, U212A, and U211C are used to generate the signal for AS. U212B and U211B are used to generate the signal for DS. The output of one of the internal dividers (SQW) of U213-23 is routed through U211D to interrupt input on U214-40. The IRQ interrupt output on U213-19 is used in the sleep mode to pulse the reset circuitry, which in turn checks to see if the Robot is still in the sleep mode.

RESET CIRCUITRY

U222A, U222B, U222C, U221B, U221C, U221D, and U221F are used in the reset circuitry. When the reset line is pulled low, U222A-9 goes high. This high is coupled through inverter amplifier U221F to turn on the 5-volt switching regulator. It also puts a high on U222-10, which resets the CPU and interface ICs (through buffer amplifier U221C and U221D). At the same time, U222B-6 goes low enabling address decoder U202.

LED INDICATORS

The LEDs are activated when data is put on port $D840 (U215-2 through 9). These lines are used in parallel to drive U225, which turns on the LEDs and speech synthesizer IC U223. The LEDs are turned on whenever data is output; the speech, however, is turned on only when U223 is enabled.

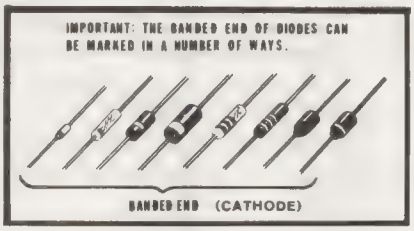
DRIVE AND STEERING

D1 on port $D821 (U214-11) turns on Q321, which controls main drive motor A2. D0 on port $D821 (U214-10) turns on Q322, which energizes RY301 to change the direction the drive motor turns.

Steering motor A1 is a stepper motor. A bit pattern on data lines D2 through D5 of port $D821 (U214-12 through 15) turns on Q316 through Q319 to activate the steering motor.

SEMICONDUCTOR IDENTIFICATION CHARTS

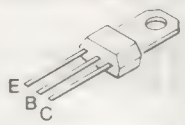
DIODES

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
D201–D203, D302, D303	56-56	1N4149	
D304	56-85	SZ5.0	
D308	56-612	1N52298	
D306, D307	56-617	1N5277B	
D305, D309, D311, D312	57-65	1N4002	
D301, D313	57-607	1N5817	

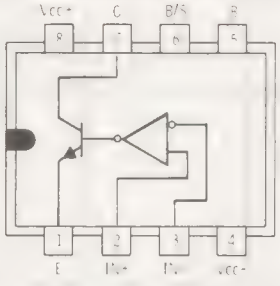
LEDs

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
D100–D107	412-640	LST5035	
D108	412-652	LT4233	

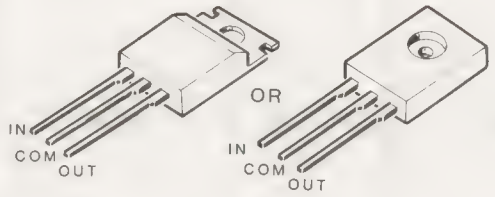
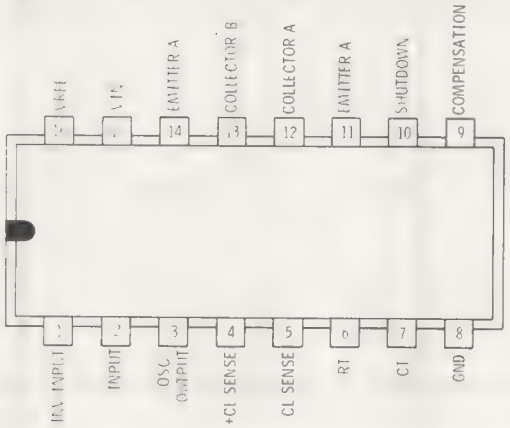
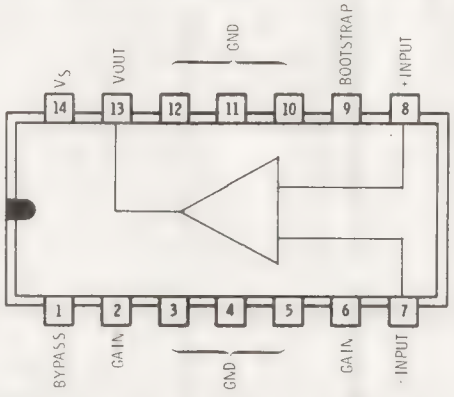
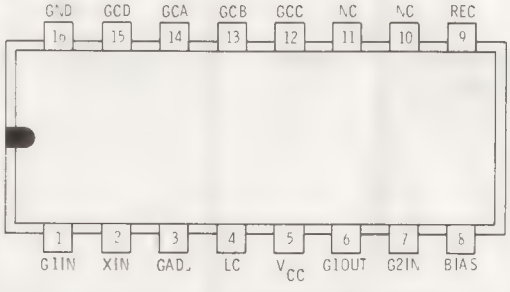
TRANSISTORS

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
Q313	417-224	MPSU05	
Q308, Q312	417-233	2N3643	
Q304, Q307, Q309	417-235	2N4121	
Q302	417-295	MPSL51	
Q202–Q204, Q206–Q209, Q303, Q305, Q306, Q311, Q315	417-801	MPSA20	
Q205, Q314	417-865	MPSA55	
Q201	417-875	2N3904	
Q322	417-881	MPSA13	
Q301	417-289	2N6109	
Q321, Q327, Q329, Q332, Q334	417-918	2N6387	

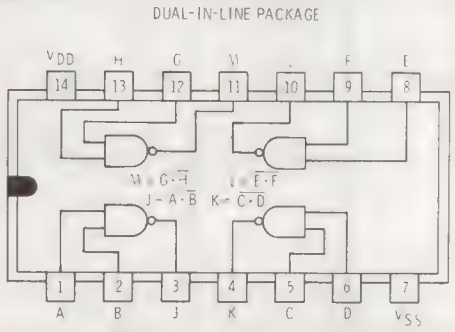
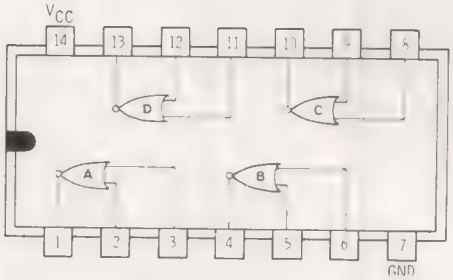
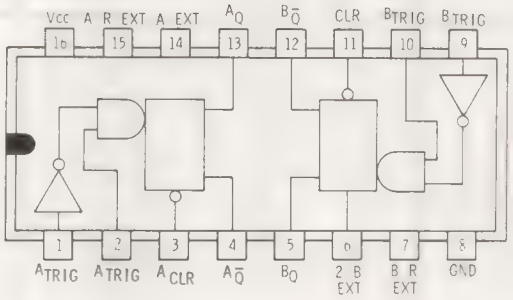
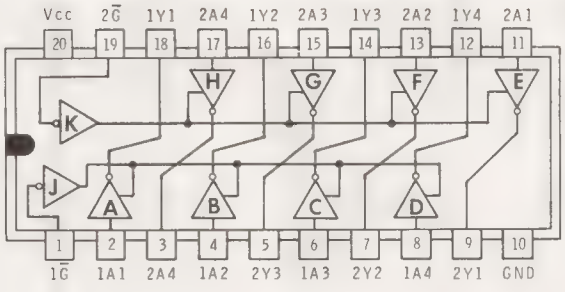
INTEGRATED CIRCUIT (ICs)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U303	442-75	311	

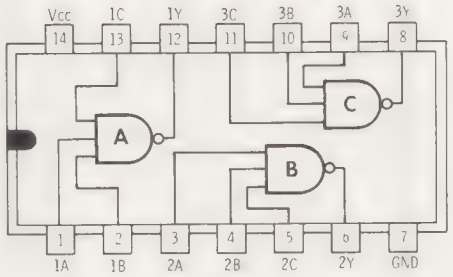
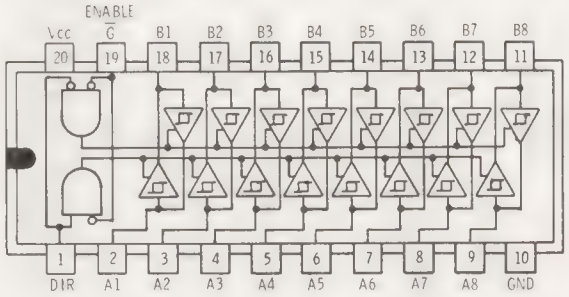
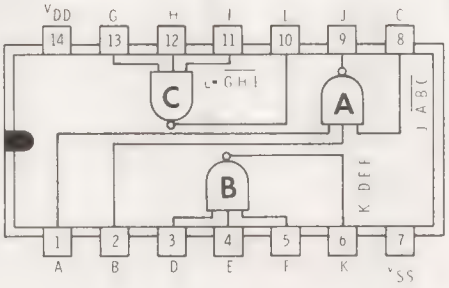
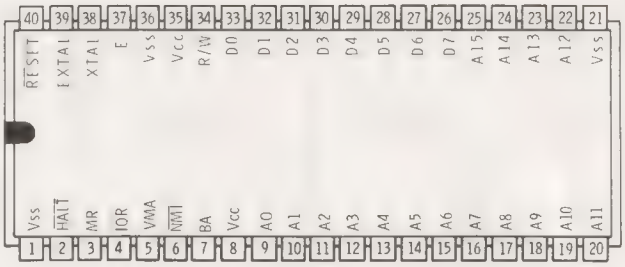
INTEGRATED CIRCUIT (ICs) (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U209	442-603	78M05	
U301	442-674	7812	
U302	442-700	3524	
U224	442-762	388N-1	
U308	442-765	TL852	

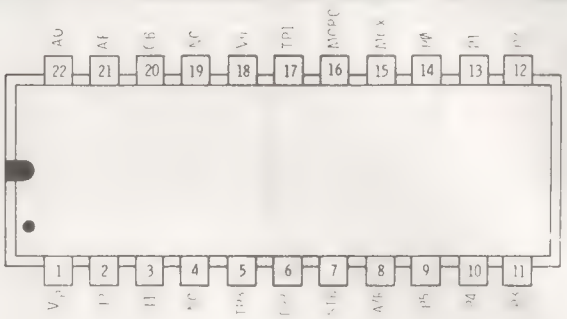
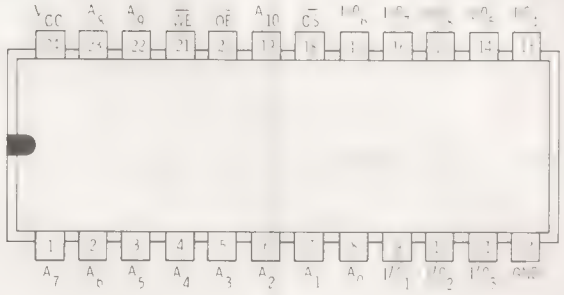
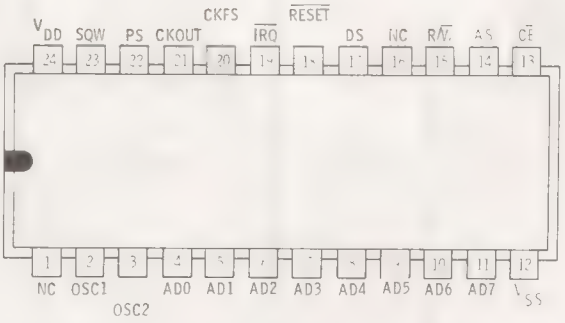
INTEGRATED CIRCUIT (ICs) (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U304	443-778	14093	
U211	443-779	74LS02	
U305	443-785	74C221	
U225, U227 U228	443-791	74LS244	

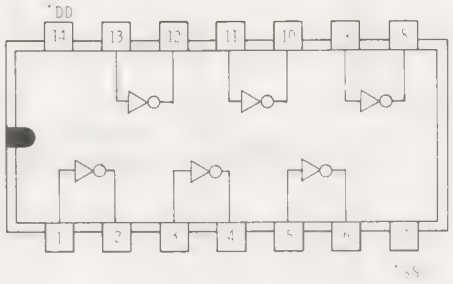
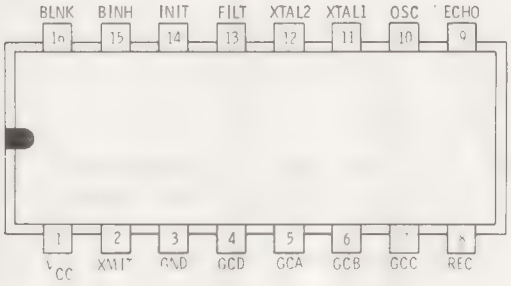
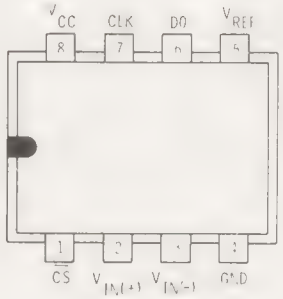
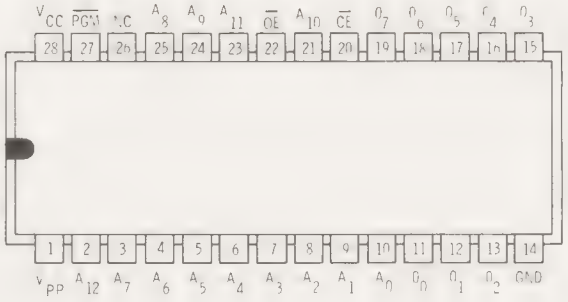
INTEGRATED CIRCUIT (ICs) (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U212	443-797	74LS10	
U226	443-885	74LS245	
U222	443-887	4023	
U201	443-939	6808	

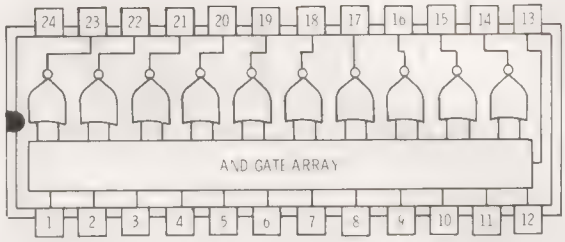
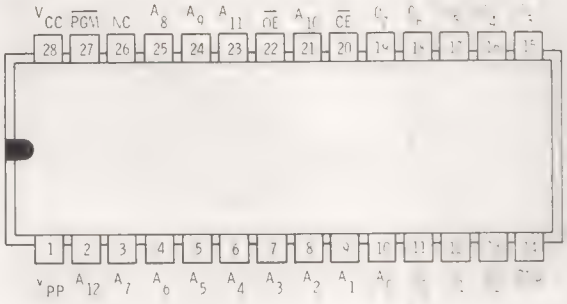
INTEGRATED CIRCUIT (ICs) (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U223	443-995	SC01	
U214, U215	443-1014	68A21	
U203	443-1027	6116	
U213	443-1139	146818	

INTEGRATED CIRCUIT (ICs) (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U221	443-1155	4069	
U307	443-1188	TL851	
U306	443-1189	ADC0831	
U208	444-254-2	Available only from Heath Co.	

INTEGRATED CIRCUIT (ICs) (Cont'd.)

CIRCUIT COMPONENT NUMBER	HEATH PART NUMBER	MAY BE REPLACED WITH	IDENTIFICATION (TOP VIEW)
U207	444-283-2	Available only from Heath Co.	
U202	444-295	Available only from Heath Co.	

REPLACEMENT PARTS LISTS

To order a replacement part, use the Parts Order Form supplied. If a Parts Order Form is not available, refer to "Replacement Parts" inside the rear cover of this Manual.

KEYBOARD CIRCUIT BOARD

LEDs

D100	412-640	LST5035 (red)
D101	412-640	LST5035 (red)
D102	412-640	LST5035 (red)
D103	412-640	LST5035 (red)
D104	412-640	LST5035 (red)
D105	412-640	LST5035 (red)
D106	412-640	LST5035 (red)
D107	412-640	LST5035 (red)
D108	412-652	LT4233 (green)

CPU CIRCUIT BOARD

RESISTORS-CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise noted.

R201	6-103-12	10 kΩ resistor
R202	6-103-12	10 kΩ resistor
R203	6-103-12	10 kΩ resistor
R204	Not used	
R205	6-472-12	4700 Ω resistor
R206	6-473-12	47 kΩ resistor
R207	6-103-12	10 kΩ resistor
R208	6-102-12	1000 Ω resistor
R209	6-103-12	10 kΩ resistor
R210	Not used	
R211	6-154-12	150 kΩ resistor
R212	1-70	22 MΩ, 1/2-watt resistor
R213	6-274-12	270 kΩ resistor

Resistors — Controls (Cont'd.)

R214	6-103-12	10 kΩ resistor
R215	Not used	
R216	6-103-12	10 kΩ resistor
R217	6-103-12	10 kΩ resistor
R218	6-683-12	68 kΩ resistor
R219	6-104-12	100 kΩ resistor
R220	Not used	
R221	6-683-12	68 kΩ resistor
R222	6-104-12	100 kΩ resistor
R223	6-272-12	2700 Ω resistor
R224	10-312	10 kΩ control
R225	6-103-12	10 kΩ resistor
R226	6-222-12	2200 Ω resistor
R227	6-472-12	4700 Ω resistor
R228	6-103-12	10 kΩ resistor
R229	6-681-12	680 Ω resistor
R230	Not used	
R231	6-229-12	2.2 Ω resistor
R232	6-472-12	4700 Ω resistor
R233	6-562-12	5600 Ω resistor
R234	10-390	20 kΩ control
R235	6-681-12	680 Ω resistor
R236	6-511-12	510 Ω resistor
R237	6-511-12	510 Ω resistor
R238	6-681-12	680 Ω resistor
R239	6-681-12	680 Ω resistor
R240	Not used	
R241	6-681-12	680 Ω resistor
R242	6-681-12	680 Ω resistor
R243	6-681-12	680 Ω resistor
R244	6-681-12	680 Ω resistor
R245	6-681-12	680 Ω resistor
R246	6-681-12	680 Ω resistor
R247	6-681-12	680 Ω resistor
R248	Not used	
R249	6-103-12	10 kΩ resistor
R250	Not used	
R251	6-473-12	47 kΩ resistor
R252	6-104-12	100 kΩ resistor
R253	6-473-12	47 kΩ resistor
R254	6-104-12	100 kΩ resistor
R255	6-473-12	47 kΩ resistor
R256	6-104-12	100 kΩ resistor
R257	6-473-12	47 kΩ resistor
R258	6-104-12	100 kΩ resistor
R259	6-153-12	15 kΩ resistor
R260	Not used	
R261	6-103-12	10 kΩ resistor

CAPACITORS

C201	25-879	4.7 µF electrolytic
C202	21-743	27 pF ceramic
C203	21-743	27 pF ceramic

Capacitors (Cont'd.)

C204	21-761	.01 µF glass ceramic
C205	21-761	.01 µF glass ceramic
C206	21-761	.01 µF glass ceramic
C207	21-761	.01 µF glass ceramic
C208	21-761	.01 µF glass ceramic
C209	21-761	.01 µF glass ceramic
C210	21-761	.01 µF glass ceramic
C211	21-761	.01 µF glass ceramic
C212	21-761	.01 µF glass ceramic
C213	21-761	.01 µF glass ceramic
C214	21-761	.01 µF glass ceramic
C215	21-762	.1 µF glass ceramic
C216	25-879	4.7 µF electrolytic
C217	21-762	.1 µF glass ceramic
C218	21-761	.01 µF glass ceramic
C219	21-761	.01 µF glass ceramic
C220	Not used	
C221	21-761	.01 µF glass ceramic
C222	21-761	.01 µF glass ceramic
C223	21-762	.1 µF glass ceramic
C224	21-763	330 pF glass ceramic
C225	21-763	330 pF glass ceramic
C226	21-46	.005 µF ceramic
C227	21-757	22 pF ceramic
C228	31-57	2.7-20 pF trimmer
C229	27-86	.47 µF Mylar
C230	21-762	.1 µF glass ceramic
C231	20-115	300 pF mica
C232	25-905	470 µF electrolytic
C233	25-905	470 µF electrolytic
C234	27-85	.22 µF Mylar
C235	25-907	4.7 µF nonpolarized electrolytic
C236	21-75	100 pF ceramic
C237	25-917	10 µF electrolytic
C238	25-924	2.2 µF electrolytic
C239	21-143	.05 µF ceramic
C240	Not used	
C241	25-905	470 µF electrolytic
C242	25-905	470 µF electrolytic
C243	Not used	
C244	21-761	.01 µF glass ceramic
C245	21-761	.01 µF glass ceramic
C246	21-761	.01 µF glass ceramic
C247	21-761	.01 µF glass ceramic
C248	21-761	.01 µF glass ceramic
C249	21-761	.01 µF glass ceramic
C250	Not used	
C251	21-761	.01 µF glass ceramic
C252	21-761	.01 µF glass ceramic
C253	21-761	.01 µF glass ceramic
C254	21-761	.01 µF glass ceramic
C255	21-761	.01 µF glass ceramic

DIODES

(Also see Semiconductor Identification Charts)

D201	56-56	1N4149
D202	56-56	1N4149
D203	56-56	1N4149

TRANSISTORS

(Also see Semiconductor Identification Charts)

Q201	417-875	2N3904
Q202	417-801	MPSA20
Q203	417-801	MPSA20
Q204	417-801	MPSA20
Q205	417-801	MPSA20
Q206	417-801	MPSA20
Q207	417-801	MPSA20
Q208	417-801	MPSA20
Q209	417-801	MPSA20

INTEGRATED CIRCUITS

(Also see Semiconductor Identification Charts)

U201	443-939	6808
U202	444-295	*
U203	443-1027	6116
U204	Accessory	
U205	Accessory	
U206	Accessory	
U207	444-283-1	*
U208	444-254-1	*
U209	442-603	78M05

* Available only from Heath Company.

Integrated Circuits (Cont'd.)

U210	Not used	
U211	443-779	74LS02
U212	443-797	74LS10
U213	443-1139	146818
U214	443-1014	68A21
U215	443-1014	68A21
U216	Accessory	
U217	Accessory	
U218	Accessory	
U219	Accessory	
U220	Not used	
U221	443-1155	4069
U222	443-887	4023
U223	443-995	SC01
U224	442-762	388N-1
U225	443-791	74LS244

MISCELLANEOUS

L201	235-229	35 mH RF choke
L202	235-229	35 mH RF choke
L203	45-47	2 mH RF choke
L204	Not used	
L205	235-229	35 mH RF choke
Y201	404-536	4 MHz crystal
Y202	404-624	32.768 kHz crystal

POWER/SENSE CIRCUIT BOARD

RESISTORS-CONTROLS

NOTE: The following resistors are rated at 1/4-watt and have a tolerance of 5% unless otherwise noted.

R301	6-681-12	680 Ω resistor
R302	6-1501-12	1500 Ω, 1% resistor
R303	6-1870-12	187 Ω, 1% resistor
R304	6-5491-12	5490 Ω, 1% resistor
R305	6-4751-12	4750 Ω, 1% resistor
R306	6-4751-12	4750 Ω, 1% resistor
R307	6-4751-12	4750 Ω, 1% resistor
R308	6-3012-12	30.1 kΩ, 1% resistor
R309	6-472-12	4700 Ω resistor
R310	Not used	
R311	6-511-12	510 Ω resistor
R312	6-102-12	1000 Ω resistor
R313	6-152-12	1500 Ω resistor
R314	6-123-12	12 kΩ resistor
R315	6-821-12	820 Ω resistor
R316	6-8873-12	887 kΩ, 1% resistor
R317	6-7503-12	750 kΩ, 1% resistor
R318	6-103-12	10 kΩ resistor
R319	6-271-12	270 Ω resistor
R320	Not used	
R321	6-104-12	100 kΩ resistor

Resistors — Controls (Cont'd.)

R322	6-104-12	100 kΩ resistor
R323	6-472-12	4700 Ω resistor
R324	6-564-12	560 kΩ resistor
R325	Not used	
R326	6-472-12	4700 Ω resistor
R327	6-472-12	4700 Ω resistor
R328	6-472-12	4700 Ω resistor
R329	6-472-12	4700 Ω resistor
R330	Not used	
R331	6-471-12	470 Ω resistor
R332	6-472-12	4700 Ω resistor
R333	6-472-12	4700 Ω resistor
R334	6-472-12	4700 Ω resistor
R335	6-472-12	4700 Ω resistor
R336	6-225-12	2.2 MΩ resistor
R337	10-928	1 MΩ control
R338	6-470-12	47 Ω resistor
R339	6-470-12	47 Ω resistor
R340	Not used	
R341	6-103-12	10 kΩ resistor
R342	6-102-12	1000 Ω resistor
R343	6-472-12	4700 Ω resistor
R344	6-102-12	1000 Ω resistor
R345	6-102-12	1000 Ω resistor
R346	6-472-12	4700 Ω resistor
R347	6-472-12	4700 Ω resistor
R348	6-104-12	100 kΩ resistor
R349	10-1049	2 MΩ control
R350	Not used	
R351	6-103-12	10 kΩ resistor
R352	6-470-12	470 Ω resistor
R353	6-102-12	1000 Ω resistor
R354	6-152-12	1500 Ω resistor
R355	6-472-12	4700 Ω resistor
R356	6-103-12	10 kΩ resistor
R357	6-103-12	10 kΩ resistor
R358	6-683-12	68 kΩ resistor
R359	6-9091-12	9090 Ω resistor
R360	Not used	
R361	6-4991-12	4990 Ω resistor
R362	6-472-12	4700 Ω resistor
R363	6-681-12	680 Ω resistor
R364	6-103-12	10 kΩ resistor
R365	6-472-12	4700 Ω resistor
R366	6-103-12	10 kΩ resistor
R367	6-103-12	10 kΩ resistor
R368	6-102-12	1000 Ω resistor
R369	6-102-12	1000 Ω resistor
R370	6-106-12	10 MΩ resistor
R371	6-102-12	1000 Ω resistor
R372	6-102-12	1000 Ω resistor
R373	6-102-12	1000 Ω resistor
R374	6-102-12	1000 Ω resistor

CAPACITORS

C301	25-922	.68 µF electrolytic
C302	21-762	.1 µF glass ceramic
C303	21-762	.1 µF glass ceramic

Capacitors (Cont'd.)

C304	21-761	.01 µF glass ceramic
C305	25-917	10 µF electrolytic
C306	21-761	.01 µF glass ceramic
C307	21-761	.01 µF glass ceramic
C308	21-761	.01 µF glass ceramic
C309	21-762	.1 µF glass ceramic
C310	Not used	
C311	25-935	1000 µF electrolytic
C312	25-948	100 µF electrolytic
C313	25-905	470 µF electrolytic
C314	21-762	.1 µF glass ceramic
C315	25-917	10 µF electrolytic
C316	21-762	.1 µF glass ceramic
C317	21-761	.01 µF glass ceramic
C318	21-762	.1 µF glass ceramic
C319	27-64	.033 µF Mylar
C320	Not used	
C321	21-763	330 pF glass ceramic
C322	21-784	.001 µF glass ceramic
C323	25-948	100 µF electrolytic
C324	27-64	.033 µF Mylar
C325	25-948	100 µF electrolytic
C326	21-763	330 pF glass ceramic
C327	25-948	100 µF electrolytic
C328	21-762	.1 µF glass ceramic
C329	25-948	100 µF electrolytic
C330	Not used	
C331	21-762	.1 µF glass ceramic
C332	21-762	.1 µF glass ceramic
C333	27-103	.0022 µF Mylar
C334	25-900	1 µF electrolytic
C335	21-784	.001 µF glass ceramic
C336	21-761	.01 µF glass ceramic
C337	21-761	.01 µF galss ceramic
C338	25-935	1000 µF electrolytic
C339	21-761	.01 µF glass ceramic
C340	Not used	
C341	25-917	10 µF electrolytic
C342	21-762	.1 µF glass ceramic
C343	21-762	.1 µF glass ceramic
C344	21-762	.1 µF glass ceramic
C345	21-762	.1 µF glass ceramic
C346	21-762	.1 µF glass ceramic
C347	21-762	.1 µF glass ceramic

DIODES

(Also see Semiconductor Identification Charts)

D301	57-607	1N5817
D302	56-56	1N4149
D303	56-56	1N4149
D304	56-56	1N4149
D305	57-65	1N4002
D306	56-617	1N5277B
D307	56-617	1N5277B
D308	56-612	1N5229B
D309	57-65	1N4002
D310	Not used	
D311	57-65	1N4002
D312	57-65	1N4002
D313	57-607	1N5817

TRANSISTORS

(Also see Semiconductor Identification Charts)

Q301	417-289	2N6109
Q302	417-295	MPSL51
Q303	417-801	MPSA20
Q304	417-235	2N4121
Q305	417-801	MPSA20
Q306	417-801	MPSA20
Q307	417-235	2N4121
Q308	417-233	2N3643
Q309	417-235	2N4121
Q310	Not used	
Q311	417-801	MPSA20
Q312	417-233	2N3643
Q313	417-224	MPSU05
Q314	417-865	MPSA55
Q315	417-801	MPSA20
Q316	417-918	2N6387
Q317	417-918	2N6387
Q318	417-918	2N6387
Q319	417-918	2N6387
Q320	Not used	
Q321	417-918	2N6387
Q322	417-881	MPSA13

INTEGRATED CIRCUITS

(Also see Semiconductor Identification Charts)

U301	442-674	7812
U302	442-700	3524
U303	442-75	311
U304	443-778	14093
U305	443-785	74C221
U306	443-1189	ADC0831
U307	443-1188	TL851CN
U308	442-765	TL852CN

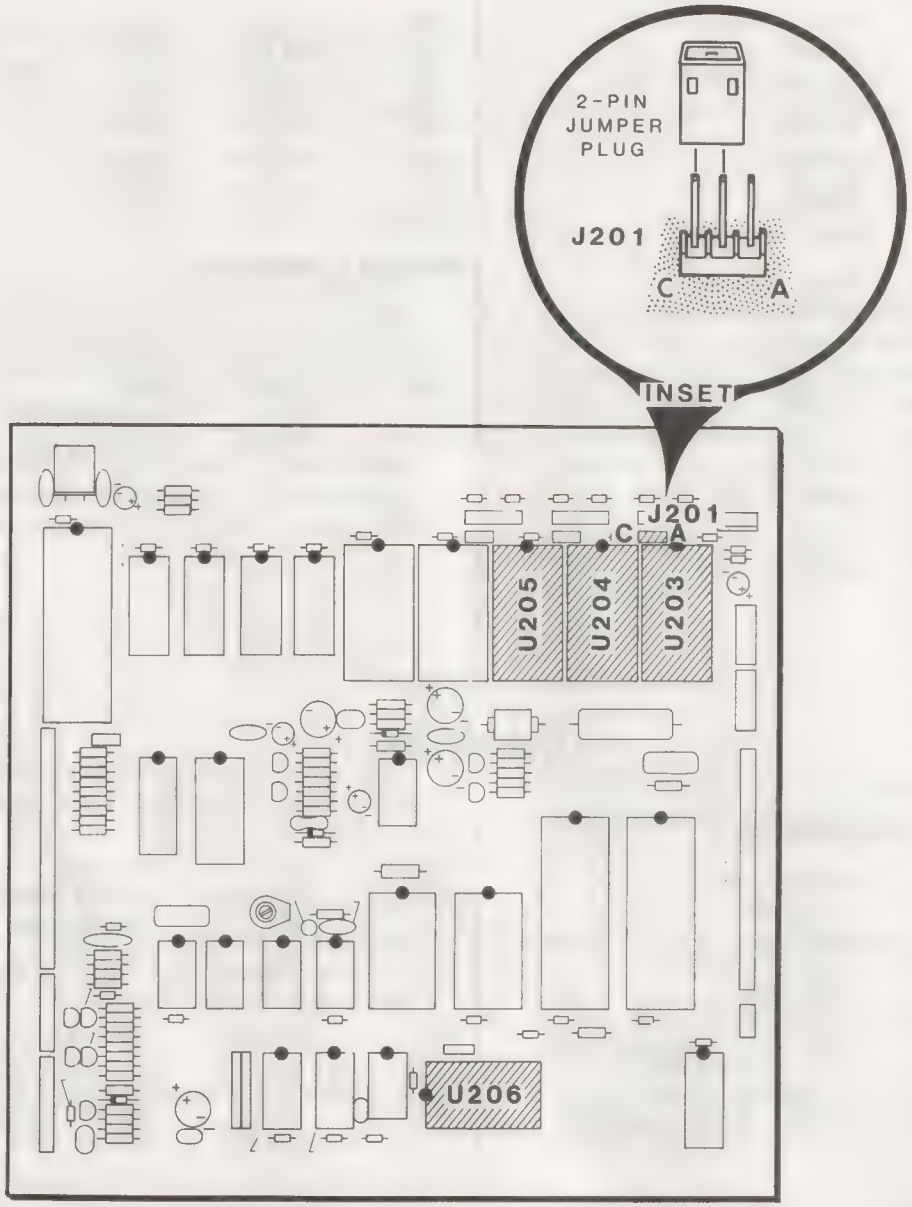
MISCELLANEOUS

L301	46-71	650 'H choke
L302	40-2119	1 mH choke
RY301	69-106	Relay
T301	52-194	Sonar transformer
Y301	404-682	420 kHz crystal

CHASSIS

ELECTRONIC COMPONENTS

A1	420-640	Steering motor
A2	420-648	Drive motor
A3	150-131	Light sensor
A4	473-35	Sonar transducer
B1	418-45	6-volt battery
B2	418-45	6-volt battery
C1	21-21	200 pF ceramic capacitor
C2	21-21	200 pF ceramic capacitor
C3	27-85	.22 µH Mylar capacitor
F1	421-5	4-ampere, 3AG, slow-blow fuse
FB1	475-18	Ferrite core
L1	45-62	26 µH RF choke
L2	45-62	26 µH RF choke
LDR1	9-67	Optical switch
R1	1-185-12	1.8 MΩ, 1/4-watt, 5% resistor
SP1	401-163	45-ohm speaker
SP2	235-302	8-ohm speaker
SW1	60-601	3-lug slide switch
SW2	60-20	9-lug slide switch
	235-282	Battery charger



PICTORIAL 2-1

APPENDIX

ROM/RAM OPTIONS AND CPU JUMPER PLACEMENT

Your HERO Jr Robot is supplied with a 2K × 8 RAM at U203 on the CPU circuit board. Right next to this RAM are two jumpers, which are configured to facilitate proper operation with the system. If you ever add the optional ROMs (or RAMs) at U204 and U205, or change the operating system RAM at U203, you will need the information on Page 44 to place the jumper for each location correctly.

You may use any one of two different sizes (2K × 8 or 8K × 8) of RAMs for U203, either 2K × 8 or 8K × 8 ROMs or RAMs at U204 and U205, and either a 4K × 8 or 8K × 8 ROM at U206, provided that these ICs conform to the industry standard pinouts for such devices.

Refer to the table on Page 44 for jumper placement for the standard RAM at U203, for all other types of RAMs in U203 through U205, and for two possible types of ROMs at U206. Pictorial 2-1 shows the locations for U203 through U206 on the CPU circuit board, and the inset drawing illustrates jumper position C-B. The table illustrates which jumpers are required for each position and ROM or RAM type.

		2K × 8 RAM 6116	8K × 8 RAM 6264	4K × 8 ROM 2532	8K × 8 ROM
U203	MEMORY RETAINED DURING SLEEP	J201 B-A J202 D-E	J201 C-B J202 A-B D-E		
	MEMORY LOST DURING SLEEP	J201 B-A J202 E-F	J201 C-B J202 B-C E-F		
U204	MEMORY RETAINED DURING SLEEP	J203 B-A J204 D-E	J203 C-B J204 A-B D-E		2764 J203 C-B J204 B-C E-F
	MEMORY LOST DURING SLEEP	J203 B-A J204 E-F	J203 C-B J204 B-C E-F		
U205	MEMORY RETAINED DURING SLEEP	J205 B-A J206 D-E	J205 C-B J206 A-B D-E		2764 J205 C-B J206 B-C E-F
	MEMORY LOST DURING SLEEP	J205 B-A J206 E-F	J205 C-B J206 B-C E-F		
U206				J207 B-A	68764 J207 C-B

CUSTOMER SERVICE

REPLACEMENT PARTS

Please provide complete information when you request replacements from either the factory or Heath Electronic Centers. Be certain to include the **HEATH** part number exactly as it appears in the parts list.

ORDERING FROM THE FACTORY

Print all of the information requested on the parts order form furnished with this product and mail it to Heath. For telephone orders (parts only) dial 616 982-3571. If you are unable to locate an order form, write us a letter or card including:

- Heath part number.
- Model number.
- Date of purchase.
- Location purchased or invoice number.
- Nature of the defect.
- Your payment or authorization for COD shipment of parts not covered by warranty.

Mail letters to: Heath Company
Benton Harbor
MI 49022
Attn: Parts Replacement

Retain original parts until you receive replacements. Parts that should be returned to the factory will be listed on your packing slip.

OBTAINING REPLACEMENTS FROM HEATH ELECTRONIC CENTERS

For your convenience, "over the counter" replacement parts are available from the Heath Electronic Centers listed in your catalog. Be sure to bring in the original part and purchase invoice when you request a warranty replacement from a Heath Electronic Center.

TECHNICAL CONSULTATION

Need help with your kit? — Self-Service? — Construction? — Operation? — Call or write for assistance. you'll find our Technical Consultants eager to help with just about any technical problem except "customizing" for unique applications.

The effectiveness of our consultation service depends on the information you furnish. Be sure to tell us:

- The Model number and Series number from the blue and white label.
- The date of purchase.
- An exact description of the difficulty.
- Everything you have done in attempting to correct the problem.

Also include switch positions, connections to other units, operating procedures, voltage readings, and any other information you think might be helpful.

Please do not send parts for testing, unless this is specifically requested by our Consultants.

Hints: Telephone traffic is lightest at midweek — please be sure your Manual and notes are on hand when you call.

Heathkit Electronic Center facilities are also available for telephone or "walk-in" personal assistance.

REPAIR SERVICE

Service facilities are available, if they are needed, to repair your completed kit. (Kits that have been modified, soldered with paste flux or acid core solder, cannot be accepted for repair.)

If it is convenient, personally deliver your kit to a Heathkit Electronic Center. For warranty parts replacement, supply a copy of the invoice or sales slip.

If you prefer to ship your kit to the factory, attach a letter containing the following information directly to the unit:

- Your name and address.
- Date of purchase and invoice number.
- Copies of all correspondence relevant to the service of the kit.
- A brief description of the difficulty.
- Authorization to return your kit COD for the service and shipping charges. (This will reduce the possibility of delay.)

Check the equipment to see that all screws and parts are secured. (Do not include any wooden cabinets or color television picture tubes, as these are easily damaged in shipment. Do not include the kit Manual.) Place the equipment in a strong carton with at least THREE INCHES of *resilient* packing material (shredded paper, excelsior, etc.) on all sides. Use additional packing material where there are protrusions (control sticks, large knobs, etc.). If the unit weighs over 15 lbs., place this carton in another one with 3/4" of packing material between the two.

Seal the carton with reinforced gummed tape, tie it with a strong cord, and mark it "Fragile" on at least two sides. Remember, the carrier will not accept liability for shipping damage if the unit is insufficiently packed. Ship by prepaid express, United Parcel Service, or insured Parcel Post to:

Heath Company
Service Department
Benton Harbor, Michigan 49022

HEATH COMPANY • BENTON HARBOR, MICHIGAN

THE WORLD'S FINEST ELECTRONIC EQUIPMENT IN KIT FORM

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